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Multiplicity Distributions in $\bar{p}p$ Interactions at $\sqrt{s}$ = 1800 Gev

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Abstract

Preliminary results on multiplicity distributions at $\sqrt{s} = 1800$ GeV in the η intervals $|\eta| \leq 2.5, 2.0, 1.5, 1.0, 0.5$ are presented. The data were collected with a minimum bias trigger by the Collider Detector at Fermilab in two different runs. A small sample of data at $\sqrt{s} = 630$ GeV was used for comparison with lower energy results and for checking on systematic effects. The multiplicity distributions at $\sqrt{s} = 1800$ GeV deviate from the negative binomial distribution in rapidity intervals larger than $|\eta| \geq 0.5$. This confirms the trend already observed at $\sqrt{s} = 900$ GeV where the deviation from the negative binomial starts at $|\eta| > 2.5$.

The multiplicity distribution of charged particles produced in high energy collisions has been extensively studied for a large variety of interactions (*hh, lh, ll, NN*) and at different energies [1, 2, 3]. In $\bar{p}p$ interactions the highest energy results available come from the CERN SpS Collider[4, 5, 6, 7].

These data cover the center of mass energy range from 200 to 900 GeV and are given for the full phase space as well as for restricted pseudorapidity intervals. In this note preliminary results on multiplicity distribution studies in $\bar{p}p$ non-single diffractive events at $\sqrt{s} = 1800$ GeV are presented. The multiplicity distributions are measured in pseudo-rapidity intervals, in the central region, below $|\eta| \leq 2.5$.

The data were collected with a minimum bias trigger during the 1988/89 run. Two small samples of data collected with the same trigger at $\sqrt{s} = 1800$ and 630 GeV in the 1987 run have been used for comparison with lower energy measurements and for check on systematic effects.

The CDF experimental apparatus is described in detail elsewhere [8]. For the present analysis the charged particle tracks measured by the VTPC detector have been used.

For the description of the events and tracks selection we refer to reference [9] where detailed results of the VTPC acceptance and track reconstruction efficiency

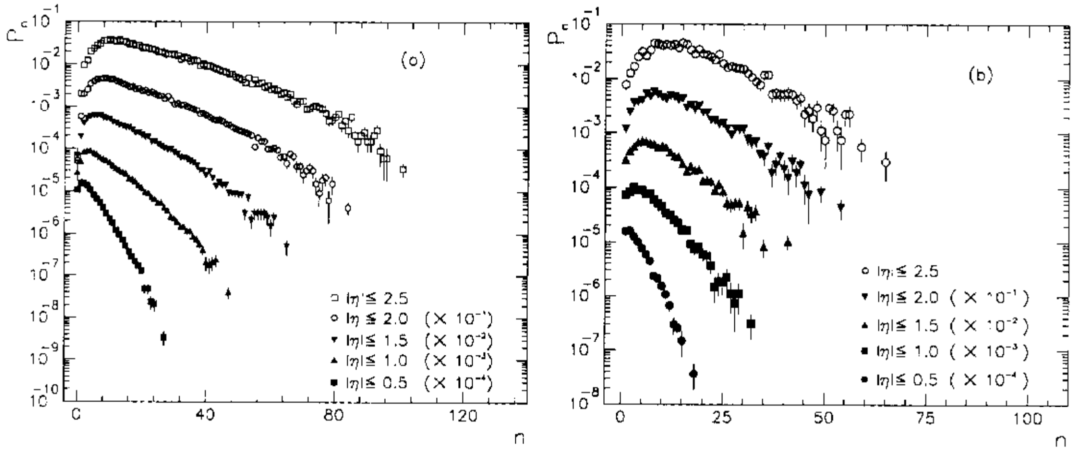

Figure 1: Raw charged particle multiplicity distributions in 5 η intervals at $\sqrt{s} = 1800$ GeV (a) and 630 Gev (b).

studies are also given (see also ref. [10]).

In fig.1a and 1b the raw multiplicity distributions for 5 η intervals ($|\eta| \leq$ 2.5, 2.0, 1.5, 1.0, 0.5) are shown for $\sqrt{s} = 1800$ Gev (fig.1a) and $\sqrt{s} = 630$ Gev (fig.1b): the probability Pn of finding an event with n charged particles vs n is plotted.

The data have been corrected for track detection and reconstruction inefficiency following the almost standard procedure described in ref.[6]. Although the optimization of the correction procedure is still under study, the effects of the correction remain rather small, given the high VTPC track finding efficiency. The background from γ conversion, neutral particle decays and secondary interactions have been subtracted.

For comparison with lower energy measurements, in figure 2 the raw distribution in the η intervals $|\eta| \leq 1.5$ at $\sqrt{s} = 630$ GeV is shown together with the negative binomial (NB) fitted distribution obtained, in the same η interval, by UA5 at $\sqrt{s} = 540$ GeV. The plots are in KNO variables, z = n/$< n >$ and Pn$< n >$. The differences in the low multiplicity region and, much less pronounced, in the high multiplicity tail, observable in figure 2 may not be accounted for by the weak KNO scaling violation in limited η intervals[7]. Investistigation on systematic effect and on the correction procedure are being carried on to bet-

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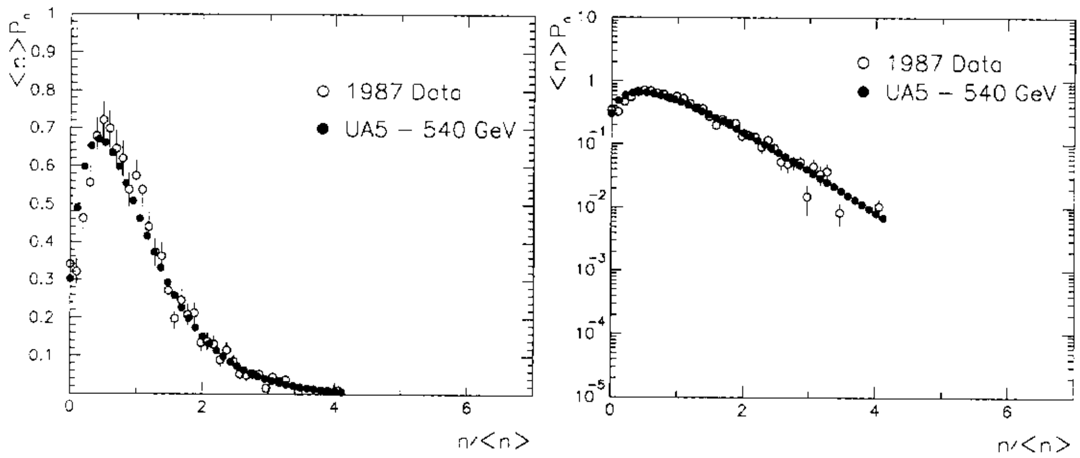

Figure 2: Raw multiplicity distributions in η interval $|\eta| \leq 1.5$ at $\sqrt{s} = 630$ GeV. Superimposed to the data are the NB fitted distributions obtained, in the same η interval, by UA5 at $\sqrt{s} = 540$ GeV. The plots are shown in linear vertical scale (left) and logarithmic scale (right), using KNO variables.

ter understand these differences. At $\sqrt{s} = 540$ GeV the multiplicity distribution is well described by the NB distribution both in full phase space and in limited η intervals. The NB fits well to our data at $\sqrt{s} = 630$ GeV. The fit result, when compared with the parameter values obtained at $\sqrt{s} = 540$ GeV, gives a compatible value, taken into account the difference in energy, for the mean multyiplicity but an higher value for the parameter k. This reflects the difference in the low multiplicity region discussed above.

The results of the NB fit to the 1800 GeV data, superimposed to the corrected distributions, are shown in fig.3a for the five η intervals. The errors in fig.3a take into account the statistical errors and the errors due to the correction procedure.

We observe that, while for the narrowest η interval ($|\eta| \leq 0.5$) the NB distribution fits acceptably to the data, it further deviates from the experimental distribution as the η window becomes wider. This is in agreement with the results of UA5 at $\sqrt{s} = 900$ GeV [7]. But at $\sqrt{s} = 1800$ GeV the NB fails to fit the data for η windows much narrower than at 900 GeV.

An accurate study of the systematic errors is currently in progress. The results shown in figures 1-3a do not include systematic uncertainties.

The mean value of the multiplicity distribution in the η interval equal to 1.5 for

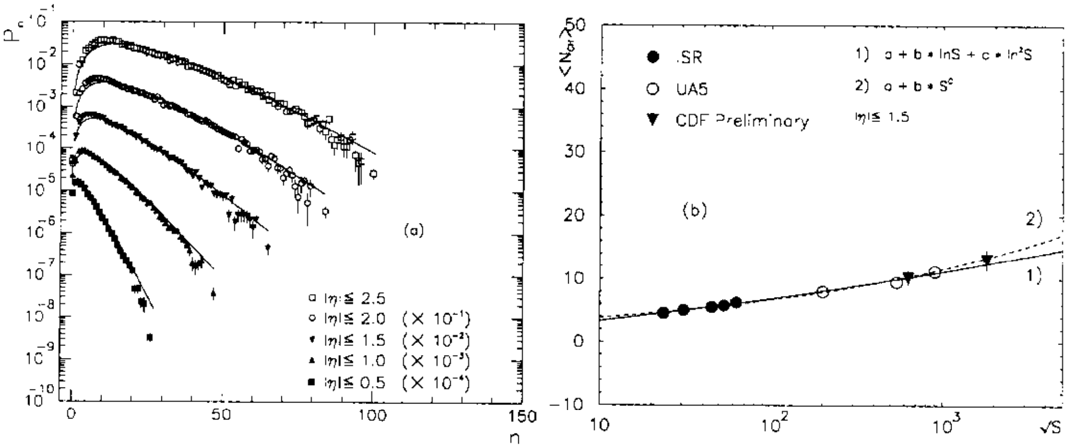

Figure 3: (a) The corrected multiplicity distributions at $\sqrt{s} = 1800$ GeV in the same 5 η intervals as in fig.1 (data points). Superimposed (solid lines) the results of the NB fit. (b) Average multiplicities in η interval $\mid \eta \mid \leq 1.5$ as a function of $\sqrt{s}$. The error bars include the systematic uncertainties.

our two energies are plotted, together with the available data at lower energies, in figure 3b. A systematic error conservatively estimated of the order of 13% has been applied to our data points. The mean multiplicity increases, as expected, with $\sqrt{s}$.

For the mean charged multiplicity measured in full phase space this dependence is usually parametrized by the forms 1) and 2) written in figure 3b. The two curves of fig.3b are the best fitted curve of the form 1) (solid line) and 2) (dotted line) to the data. Both relations give a good interpolation of the data points, but 1) gives a lower value of χ^2 per *dof.*

In conclusion the preliminary results on multiplicity distributions in $\bar{p}p$ minimum bias events at $\sqrt{s} = 1800$ GeV show that:

- The $< n_{ch} >$ measured in limited η intervals, increases with $\sqrt{s}$ with the same $log^2 s$ dependence as it does in the full phase-space, but of course with different parameters.

- The shape of the distribution, which at $\sqrt{s} = 900$ GeV deviates from the NB distribution for η intervals larger than $\pm$ 2.5 units, shows the same behaviour, but at $\sqrt{s} = 1800$ GeV, the deviation starts at η intervals larger than $\pm$ 0.5 units.

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